

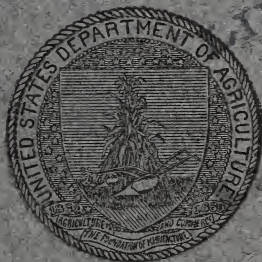
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Issued June 7, 1909.

U. S. DEPARTMENT OF AGRICULTURE,
OFFICE OF EXPERIMENT STATIONS,
A. C. TRUE, Director.

ORGANIZATION AND WORK OF THE OFFICE OF EXPERIMENT STATIONS.



WASHINGTON:
GOVERNMENT PRINTING OFFICE.

1909.

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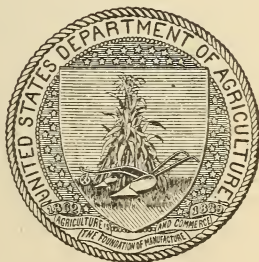
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U. S. DEPARTMENT OF AGRICULTURE,
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WASHINGTON:
GOVERNMENT PRINTING OFFICE.

1909,

LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
OFFICE OF EXPERIMENT STATIONS,
Washington, D. C., April 8, 1909.

SIR: I have the honor to transmit herewith and recommend for publication a brief general account of the organization and work of the Office of Experiment Stations. This article has been prepared mainly for distribution at the Alaska-Yukon-Pacific Exposition.

Respectfully,

A. C. TRUE,
Director.

HON. JAMES WILSON,
Secretary of Agriculture

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ORGANIZATION AND WORK OF THE OFFICE OF EXPERIMENT STATIONS.

RELATIONS OF THE OFFICE WITH THE EXPERIMENT STATIONS.

The agricultural experiment stations in the United States are State institutions supported in part by funds given by the Federal Government to the States to be used for their maintenance. The direct management of the stations is wholly in the hands of State officers. The appropriations, however, called for by the Hatch Act are made by Congress from year to year and come under the head of annual appropriations for the Department of Agriculture.

With the passage of the Hatch Act providing funds for the support of agricultural experiment stations in the various States and Territories in 1887, it became necessary to maintain an office in the Department of Agriculture intrusted with the general supervision of the work and expenditures of these stations. Accordingly the Office of Experiment Stations was established in 1888 to represent the Secretary of Agriculture in his relations with the stations. This work of supervision is, therefore, the main organic function of the Office and still remains its chief duty, although a number of other lines of work have been assigned to it.

The Office maintains very intimate relations with the stations in the several States and Territories, with the result that all of them are thereby bound together into a national system. The functions of the Office in this regard are partly supervisory and partly advisory. An annual inspection of the stations is made for the purpose of examining into their work and their expenditures under the Federal funds and for inquiring into the relations and management of the stations as well as their general efficiency.

POLICY OF INSPECTION.

The inspection of the operations of the experiment stations is of a broader character than the term would imply. It is not confined to an examination of the accounts and financial reports, but extends to all the activities of the stations and their relations to other agricultural agencies. The determination of the legality of the expenditures involves a consideration of the whole work of the stations, their efficiency, relations, and general influence. No fixed rules can be established as to the amounts of money which may be legally expended for certain apparatus, salaries for certain purposes, administration, heat, light, or other purposes. These matters must be determined independently in each case after a consideration of the demands made upon the station and the facilities which it possesses for its work.

In this annual inspection the relations of the stations to the colleges of agriculture also receive attention, particularly the matter of the division of salaries of station officials who are also teachers in the colleges, and the

purchase of equipment which is used jointly by the stations and colleges. In this inspection many problems are presented which could not be solved by an appeal to the terms of the law, but are adjusted rather by an appeal to good policy and the various interests involved. In this work a broad view of the functions of the stations has been taken, and in general the effort has been made to defend their interests and upbuild their work without in any way destroying their autonomy.

The phraseology of the Hatch Act is so broad that without a close construction the funds might be expended for too great a variety of work without accomplishing the true purpose for which they were appropriated. The attempt has been made, therefore, to bring it about that as far as the Federal appropriations are concerned they shall be restricted quite closely to expenses directly connected with experimental work and the dissemination of the results thus obtained.

The inspection of the agricultural experiment stations carried on by the Office is not confined to a brief annual visit, but is going on in one way or another throughout the year. There is a continual correspondence with the stations upon the matters of policy, progress of the work, the use of funds, etc.

The Office passes upon and approves their annual financial reports, which are made in accordance with the schedules prescribed by the Secretary of Agriculture, and on the basis of which the payments by the Treasury Department are made. Under the Adams Act, passed in 1906, the supervision of work and expenditures goes some-

what further, for the Department is charged with the administration of the law as a whole.

The advisory relations with the stations have to do largely with their general policy, organization, relations to teaching, and other lines of work, personnel, etc. From its wide acquaintance with agricultural experts and with the needs of the stations, the Office is able to assist in recruiting their working forces, and maintains a register of available men for that purpose. Furthermore, the Office points out the needs of the stations in buildings and equipment, urges the importance of arrangements which will insure time and liberty to station officials for their legitimate work, arranges for cooperation and assistance, and advocates their cause generally. Its whole effort is directed toward furthering and strengthening the stations and their work by conserving their funds, protecting their interests, stimulating their activities along lines of thorough work, and maintaining a central agency for the experiment stations and for exploiting their work.

RESULTS OF INSPECTION.

The result of this inspection and the attitude taken by the Office toward experiment station work is seen in the prevention of the dissipation of Federal funds and in the steady development of the stations in efficiency, quality of work, and concentration of effort. Its functions in this respect have been increased in importance by the passage of the Adams Act in 1906, the administration of which has been placed in charge of the Office by the Secretary of Agriculture. The work of the stations under the Adams Act is strictly confined to original research in

agricultural lines. By its interpretation of this act and the regulations regarding the expenditures of the Adams fund this Office is endeavoring to aid the stations in inaugurating a much larger amount of the more scientific and fundamental researches through which it is hoped to establish principles of wide reaching and permanent value to the agriculture of the United States. In this way, also, it is believed that a broad and firm scientific basis will be laid for the more practical work of the stations, and for the instruction in agricultural science and practice given in our agricultural colleges and schools, as well as through farmers' institutes, agricultural organizations, and the agricultural books and journals.

EXPERIMENT STATIONS IN ALASKA, HAWAII, PORTO RICO, AND GUAM.

No provision was made in the Hatch Act for the establishment of experiment stations except in the then organized States and Territories. As the need was felt for agricultural investigations in other regions provision was made in the appropriations for the Office of Experiment Stations for the establishment and maintenance of experiment stations in Alaska in 1897, in Hawaii and Porto Rico in 1901, and in Guam in 1908. The relation of the Office with these stations is different from that sustained with the stations established under the Hatch Act. The latter are partly supported by State funds and are under the control of a local governing board which appoints all officers and transacts all necessary business, subject only to the supervision of the Office, as explained on page 6. In the case of the stations in Alaska, Hawaii, Porto Rico,

and Guam, on the other hand, all appointments are made by the Secretary of Agriculture through the Office, and the officials are therefore on the roll of the Office. There is no local governing board, and the supervision of the funds and the determination of the policy of the stations originate from the Office under authority from the Secretary.

The general policy of the Office in directing the work of these stations has been to improve agricultural practice and to make such investigations as are considered necessary to develop the agricultural resources and possibilities of the Territories in which the stations are located.

ALASKA.

In Alaska, previous to the establishment of the station, it was even doubted whether the Territory was in any way suited to agricultural practices. It was necessary, therefore, to carry on experiments which would show whether the common field and garden crops and domestic animals could be successfully raised in various parts of the Territory.

The central station is located at Sitka, with branches at Rampart, Fairbanks, and Kodiak. The horticultural work in Alaska has been chiefly carried on at Sitka and is concerned with investigations of the soil requirements and cropping seasons of garden vegetables, potatoes, small cultivated fruits, and various wild fruits. A number of wild fruits of unusual promise are being tested, and some work in hybridization has been done to determine the possibility in the improvement of these wild species. In the interior of the Territory, particularly at the Fair-

banks and Rampart stations, much attention has been given to cultural experiments with cereals, hay, and forage crops. A number of varieties of wheat, oats, barley, and rye have been found which thrive excellently under the peculiar climatic conditions of the Territory.

Recently attention has been turned to the improvement of live stock. At Kenai a herd of Galloway cattle was established in 1906, which was considerably increased, and transferred to Kodiak in 1907. The purpose of this experiment is to determine the adaptability of Galloways to the climate of Alaska and their suitability for use in grading up the native cattle. An attempt will be made in breeding Galloways to produce an even longer and more curly coat than they normally possess, in order to make it of still greater value for rugs and robes. It is also hoped that the milking quality of the Galloway may be improved under proper selection. Heretofore little attention has been given to horses in Alaska on account of the great expense of keeping them over winter. This problem of winter maintenance is being investigated.

HAWAII.

In Hawaii the station is making a study of tropical agriculture, including all of the more important commercial plants of the Tropics with the exception of sugar cane, which is already provided for by the Sugar Planters' Station of Hawaii. Particular attention has been given to tobacco, coffee, rubber, rice, cotton, forage plants, bananas, citrus fruits, grapes (of which about 300 varieties are being tested), mangoes, avocados, papayas, pineapples, and sisal. Tobacco work has been

carried on in the Hamakua district. It appears that a most excellent quality of tobacco can be produced there, and the commercial development of the tobacco district is likely to follow upon these investigations.

One of the difficulties in the way of the extensive development of tropical agriculture in Hawaii has been that of securing markets and proper transportation. These problems are being studied by the station, and a number of experimental shipments of various products have been made, particularly to San Francisco, Portland, and Seattle.

In the line of forestry, experiments have been carried on to determine the value and importance of the black wattle in the production of bark for commercial purposes and on the reforestation of denuded and other areas with eucalyptus and other trees. Some experiments are being conducted with rubber tree planting and tapping, several species being under observation. Rubber of good quality has been produced from Ceara trees and the outlook for this industry appears promising.

PORTO RICO.

In Porto Rico the main station is located at Mayaguez, with a branch coffee station at La Carmelita. In general, the line of work carried on in Porto Rico is similar to that in Hawaii. Rubber has received relatively less attention, and experiments with rice have just been begun. About 100 varieties of citrus fruits are under observation. There are a number of seedling oranges, two of which are of the navel type and very excellent. Much attention has been given to pineapples, of which

25 varieties are being grown. During the past two years experimental shipments have been made to New York to determine their shipping qualities and their attractiveness in competition with other varieties of pineapples.

It has been found that, contrary to the commonly accepted notion, a number of the northern garden crops may be successfully grown in Porto Rico. The station cooperates with sugar planters in the use of fertilizers and in breeding work. About 30 varieties of coffee are being tested and some new varieties have been established. This work is being carried on very energetically, and a system of coffee nurseries has been established and is being adopted by coffee planters in the island.

The work with fiber plants is largely confined to a study of sisal and maguey. Attention is also being given to methods of covering bald hills with forest growth in order to prevent erosion.

One of the chief lines of work of the station is that of animal breeding. The native animals of the island are to a large extent of poor type, and there is abundant opportunity for improvement in all directions. An attempt is being made, therefore, to introduce better blood in horses, cattle, hogs, chickens, ducks, and geese. This work involves a careful study of acclimatization, in order to prevent a loss of vigor in imported pure-bred animals and the appearance of tropical diseases among them.

GUAM.

In 1908 Congress made an appropriation for the establishment and maintenance of a station on the island of Guam. The preliminary investigations have been made

and a station located between Agaña and Piti. Here experiments in adaptation, improvement, and methods of cultivation of the leading tropical crops have been begun, and efforts will be made to improve the different kinds of live stock, those now on the island being for the most part of very inferior strains. All agriculture on the island is in a very low state, and for some time to come most of the work of the Guam Station will of necessity be of the nature of demonstrations, showing the possibilities of improved methods, in the hope that the natives may be led to take up agricultural pursuits once more.

AGRICULTURAL EDUCATION.

There are in the United States 67 State colleges receiving aid from the Federal Government, and 64 of these institutions maintain courses in agriculture. The annual income of these institutions now amounts to more than \$18,000,000, their property is valued at \$106,000,000, and they have upward of 74,000 students enrolled, 14,000 of whom are pursuing courses in agriculture.

There are also 55 agricultural high schools receiving State aid, 16 privately endowed colleges and high schools giving secondary instruction in agriculture, 115 State and county normal schools preparing young people to teach agriculture, several hundred public and private high schools and academies giving some instruction in agriculture, and 16 institutions offering correspondence and reading courses in agriculture.

Thirteen States have enacted laws requiring the teaching of agriculture in the rural public schools and it is encouraged by State and county officers and taught in

some of the rural schools of 31 other States. In all, 44 States and outlying possessions are making some effort to teach their youth the underlying principles of agriculture.

The Office of Experiment Stations is the general agency of the Department of Agriculture to deal with the different colleges and schools in the United States concerning matters relating to the promotion of agricultural education. The State institutions mentioned above maintain an organization known as the Association of American Agricultural Colleges and Experiment Stations, and at the meetings of this association the Director of the Office represents the Department and is a member of the standing committee on instruction in agriculture. This committee has given much study to the formulation of agricultural courses, and has submitted a number of reports outlining such courses for agricultural colleges and secondary and elementary schools. The Director of the Office is also dean of the Graduate School of Agriculture, which considers methods of instruction.

For several years the Office has kept a record of progress in agricultural education in this country and abroad, by means of a study of published curricula of instruction and other literature and also by visits to the various educational institutions. Statistics and organization lists of the agricultural colleges are annually compiled and published, as are also special bulletins on different phases of agricultural education. Members of the Office staff attend and give addresses at important gatherings of agricultural educators in all parts of the country. The general field of agricultural education, as covered by the Office, is now divided for practical purposes into: (1) The educa-

tional work of agricultural colleges and schools; and (2) farmers' institutes and other forms of itinerant extension work in agriculture.

In its relations with agricultural colleges and schools, the Office follows and records the progress of agricultural education in this and foreign countries through abstracts of important literature in the Experiment Station Record and by the publication of statistics and special articles relating to the subject. A card index is kept of agricultural institutions, and lists of American institutions teaching agriculture are published from time to time. The Office gives assistance to agricultural colleges and other schools which teach agriculture in the preparation of agricultural courses and in suggestions regarding effective methods of teaching agricultural science. This work is chiefly accomplished by cooperation with the Association of American Agricultural Colleges and Experiment Stations. Much help is also rendered the agricultural organizations of the several States in promoting agricultural education in rural high schools, consolidated common schools, and other schools. The cause of agricultural education is furthered by assisting agricultural colleges and normal schools in inaugurating training courses for teachers of agriculture and by assisting these teachers to secure suitable literature and other material for their work. The Office is making a special effort to increase the efficiency of agricultural instruction in the negro land-grant colleges, in order that the funds granted for negro education by the Federal Government may contribute toward making the negro a more efficient factor in agricultural production.

An increasing demand is made upon the Office for assistance in outlining courses of study in agriculture; in procuring suitable instructors in agriculture for summer schools and teachers' institutes; in the selection of teachers, text-books, and laboratory material for agricultural schools and agricultural work in public schools; and in securing instructors and heads of departments in agricultural colleges.

FARMERS' INSTITUTES.

The Office, through the farmers' institute department, assists those in charge of farmers' institutes in the several States and Territories by collecting data and publishing information and statistics relating to institute work in this and foreign countries, by distributing agricultural literature, and by offering suggestions respecting new and improved methods for organizing and conducting farmers' institutes, as well as for perfecting those already in use. The Office is also cooperating with the standing committee on extension work of the Association of American Agricultural Colleges and Experiment Stations in collecting data respecting forms of agricultural extension with a view to assisting the colleges in organizing extension departments in agricultural education. It likewise publishes the reports of the "Proceedings of the Annual Meeting of the American Association of Farmers' Institute Workers," and prepares and edits bulletins, illustrated lectures, courses of study for movable schools of agriculture, and charts for use in institute teaching; conducts correspondence with persons interested in agricultural education; visits educational institutions in the interest of college

extension; and sends out representatives to lecture before farmers' institutes and other educational assemblies.

During the year ended June 30, 1908, farmers' institutes were held in all of the States except Louisiana and Nevada, and in all of the Territories except Alaska and Porto Rico. There were 4,643 institutes held, made up of 14,934 sessions, with a total attendance of 2,098,268. The appropriations from all sources for institute purposes for the year were \$297,356.89. Sixteen States held independent institutes with an attendance of 81,845. Eleven States held round-up institutes, consisting of 99 sessions, with an attendance of 28,910. Eight States conducted railroad specials. The attendance in 7 of these States upon these specials was 218,710. Ten States held movable schools of agriculture, with an attendance of 6,849, and 2 States held field meetings, continuing through nine days, attended by 4,100 persons. The total attendance upon these five forms of activity was 340,414, which added to the attendance at the regular institutes, 2,098,268, makes the total attendance for the year 2,438,682.

There was in addition the attendance upon the following forms of institute from which no record of the number present is given: Women's institutes in 15 States, 732 meetings; boys' institutes in 5 States, 174 meetings; normal institutes in 5 States; street fairs in 1 State, and a large number of farmers' picnics addressed by farmers' institute lecturers.

Eleven hundred and forty-two lecturers were employed by the State directors in giving instruction in the institutes during the year. Four hundred and twenty-six of

these were from the faculties of the argicultural colleges and the staffs of the agricultural experiment stations. These college and station lecturers contributed in the aggregate three thousand eight hundred and fifty-one days of time.

A proposed advance in extension work in agriculture is in the direction of the equipment and sending out of movable schools of agriculture. It is intended that instruction in these schools shall be confined to a single subject, and its scholars limited to adults who have had at least common-school training and a year's experience in the line of farming which the school represents. The length of the school term may vary from one week to two or three months, according to the nature of the subject taught. The equipment consists of apparatus sufficient to furnish each pupil with a full set for laboratory use; a library of duplicate copies for reading and reference; and also a collection of illustrative material for demonstration and practice work. The teaching is by lectures and is limited to one lecture each day. At the close of the lecture a syllabus containing references to authorities on the different points presented is furnished to each student. The lecture is immediately followed by the looking up of the references noted in the syllabus, and later by practice work in the laboratory, stable, garden, or field. The classes are composed of students who have agreed to take the entire course, and are limited in number of pupils to not less than 8 nor more than 15 in any one class. A small fee is charged to each student. The locality is expected to provide a room furnished with desks, chairs, heat, light, and other facilities, in which to hold the school; also jani-

tor services and material for laboratory use free of expense to those sending out the school.

A well-equipped school of this character is in successful operation in Iowa under the direction of the agricultural college at Ames. Agricultural colleges in the following States have likewise organized extension departments for conducting similar work: New York, Maine, Pennsylvania, Ohio, Indiana, West Virginia, Colorado, California, Illinois, Nebraska, Iowa, Kansas, Rhode Island, Utah, and Wisconsin. Agricultural colleges in the other States contemplate effecting organizations of like character.

The Office has issued publications explaining fully the organization of movable schools and giving courses of instruction for such schools in the subjects of cheese making, fruit growing, and cereal foods.

PUBLICATIONS.

The Office is required by law to make an annual report to Congress upon the progress of the stations, their work, general efficiency, usefulness, and similar matters. The compilation of agricultural information is in a special sense a leading function of the Office. A large number of technical and popular publications are prepared on a great variety of agricultural subjects. In addition to reporting the results of its own investigations on food and nutrition of man, irrigation, drainage, and the various lines of work carried on under its direction in the agricultural experiment stations of Alaska, Hawaii, Porto Rico, and Guam, the Office collects, prints, and disseminates information regarding the progress of agricultural research and education in the United States and other countries.

EXPERIMENT STATION RECORD.

The leading publication of the Office is the Experiment Station Record, a periodical which gives a technical review of the current literature of agricultural investigation, not only in the United States but throughout the world. The literature reviewed in this periodical includes not only books and annual reports relating to agriculture, but also about 1,600 periodicals in 12 or more languages. In a sense supplementing the Record, Experiment Station Work is published every two months in the series of Farmers' Bulletins of the Department, and gives popular summaries in a series of short articles of the more important practical results of agricultural investigation, particularly in the experiment stations of this country.

NUTRITION PUBLICATIONS.

The food and nutrition publications of the Office include a large number of technical and popular bulletins, circulars, and miscellaneous documents reporting or based upon the nutrition investigations of the Office and dealing with the cost, composition, and functions of food and food nutrients; the effect of milling, cooking, and other methods of treatment on the nutritive value of foods, and dietary studies and other investigations intended to promote the best utilization of agricultural food products by people belonging to various classes. Several bulletins of a technical character have been published regarding the metabolism of foods in the human body.

IRRIGATION PUBLICATIONS.

The publications of the Office on irrigation investigations relate mainly to irrigation laws and institutions, the development and status of irrigation in humid as well as in arid regions, the water requirements of crops, the duty of water in irrigation, methods of applying water, prevention of losses of water, distribution of water in the soil, use of small water supplies for irrigation, pumping water for irrigation, and other uses of power for farm purposes and farm machinery.

The publications of the Office on irrigation practice in the far West cover nearly all of the ordinary farm, garden, and food crops, while in the humid parts of the country attention has been given chiefly to rice, cranberries, and market and garden crops.

DRAINAGE PUBLICATIONS.

The publications of the Office on drainage investigations include reports on the drainage of seeped and swamped lands, protection of lands from flooding, reclamation of tidal lands, methods of drainage, comprehensive plans for the drainage of extended areas, and machinery for drainage work.

MISCELLANEOUS PUBLICATIONS.

The Office has issued a series of publications dealing with different phases of agricultural education, such as the organization of courses of instruction in agricultural colleges and secondary and elementary schools, farmers' institutes, and other forms of extension teaching in agri-

culture, movable or itinerant schools of agriculture, farmers' institute lectures, progress of agricultural education in various lines in this country and abroad, and related topics. Some of the miscellaneous publications of the Office, including the proceedings of the Association of American Agricultural Colleges and Experiment Stations and the American Association of Farmers' Institute Workers, are also of interest largely in connection with the subject of agricultural education.

ANNUAL REPORTS.

Two annual reports are issued by the Office, of which the report of the Director is a brief account of the work of the Office each year, while the other or annual report of the Office is a larger document, in which administrative details are reduced to a minimum, and an attempt is made to show the progress of agricultural research and education in the United States during the period covered by the report. This is accomplished by means of a detailed report on the work of the Office and of the several agricultural experiment stations and by articles illustrating the progress in nutrition, irrigation, and drainage investigations, farmers' institutes and agricultural education, and in various special lines of investigation at the experiment stations.

CARD INDEX.

Another important and useful publication of the Office is a card index of experiment station literature. This index is issued in a limited edition, is printed on cards

2 by 5 inches, and is of especial value to investigators along all branches of science related to agriculture. Each card contains a brief abstract embodying the results of experiments along the various lines of work conducted by the agricultural experiment stations. The index is sold as a whole at the rate of \$2 per thousand cards and also as separate divisions.

LISTS OF PUBLICATIONS.

A monthly list of the current experiment station publications is also issued, of interest chiefly to librarians and those specially interested in following the publications of the experiment stations in the United States. Detailed and classified lists of the Office publications, explaining their nature and how they may be obtained, may be had on application to the Director of the Office.

LIBRARY.

The library of the Office is an essential part of its working equipment and maintains practically complete sets of the publications of the Department of Agriculture and of the State experiment stations bound and conveniently arranged. The librarian also examines new publications for the purpose of aiding in selection of material for review in the Record, and assists in reference and bibliographical work of various kinds.

NUTRITION INVESTIGATIONS.

The nutrition investigations of the Office were begun in 1894 on a cooperative basis. In this work the Office has been associated with agricultural colleges, experi-

ment stations, universities, and other educational or philanthropic institutions. The cooperative work has been done in 19 States and 3 Territories.

The work is now centered in Washington, where experiments will be carried on supplementing the work of the other Bureaus of the Department.

The chief object of the nutrition investigations has been to learn the nutritive value of agricultural products of animal and vegetable origin and the ways in which such materials may best be used as human food. The work has, in the main, consisted of dietary studies, digestion experiments, studies of the metabolism of matter and energy, changes brought about in meat, legumes, flour, and other food products by cooking, and also investigations of experimental methods and the construction of apparatus used in nutrition work.

In the cooperative investigations which proved so valuable the various problems to be studied were assigned to institutions which were best fitted for carrying on the particular kind of work. Thus in California the nutritive value of fruits and nuts has been studied. In Connecticut investigations have been made on the relative values of fats and carbohydrates in the diet, and other questions relating to the fundamental laws of nutrition. In this connection, the respiration calorimeter, devised by the nutrition experts, has rendered signal service. In Maine and Minnesota studies have been made on the nutritive value of flour, cereal breakfast foods, and other cereal products, while in Illinois investigations were carried on regarding the nutritive value of meat, the changes due to cooking by different methods, and its digestibility

under different conditions. In Tennessee the digestibility and nutritive value of various legumes have been studied. Cooperative experiments have also been undertaken in Connecticut and Minnesota to determine the digestibility of American Cheddar cheese made with different proportions of rennet and cured for different lengths of time. Other kinds of cheese were also studied. In these experiments cheese was readily digested and was eaten at the rate of one-half pound per day without causing digestive disturbances of any sort. Bulletins recently published have to do with the digestibility of starch of different sorts as affected by cooking, the nutritive value of milk, the influence of muscular and mental work on metabolism, and the efficiency of the human body as a machine.

The place of fruits and nuts in the diet has been indicated, and the relative nutritive values and physiological effects of graham, whole wheat, and standard patent flours have been determined. By means of comparative experiments the relative losses of different nutritive constituents in cooking meat in different ways have been accurately determined. In this work it was also found that the factors which determine the flavor and appearance of cooked meat are readily controllable.

The results of the nutrition investigations have been published in about 60 technical bulletins, 50 Farmers' Bulletins, and other popular articles. The nutrition investigations have rendered available a large amount of statistical and other data regarding the composition and nutritive value of foods, their digestibility, and the kind and amount of nutritive material required by individuals

living under different conditions which is of value as a basis for the formulation of dietaries.

Rooms were set aside for the respiration calorimeter in the new Department of Agriculture building, and the instrument, formerly in Middletown, Conn., has been installed with some important improvements. In its present form the calorimeter is without doubt the most accurate and satisfactory apparatus which has been devised for studying by means of variations in the metabolism of matter and energy the relative digestibility of foods, the value of different foods for building the body and supplying it with energy, the energy required for different forms of farm, household, or other work, and many other problems pertaining to the rational nutrition of the body and the relative food value of agricultural products.

Courses in home economics, of which nutrition is an important part, are now given at many of the agricultural colleges, and are also included in the work of other colleges and universities and in high schools. The results of the nutrition investigations in the Department of Agriculture are very extensively used in this work, the bulletins and other publications serving as text-books and works of reference.

IRRIGATION INVESTIGATIONS.

Irrigation investigations have been part of the work of the Office since the season of 1899. The purpose of this work is a better use of the water supply in those sections of the country where irrigation is practiced. The work is divided into three general classes:

(1) The study of the adaptation of the laws and other institutions governing the use of water to the needs of the agricultural industry.

(2) Scientific and technical investigations of losses of irrigation water by evaporation, seepage, and in distribution, and of methods of preventing these losses; of the relation of irrigation to the quantity and quality of crops; of the adaptation of methods of applying water to soils and crops; and of the measurement, distribution, storage, and pumping of water for irrigation.

(3) The collecting and publishing of practical information regarding irrigation practice.

The earlier studies were devoted largely to work of the first class. It was found that the water laws of the arid States were in many instances not well adapted to the highest development of irrigation, and several of the bulletins published pointed out the weaknesses of these laws and recommended changes. Since the beginning of this work, laws embodying the main principles of the recommendations of this Office have been adopted in 7 States and the Territory of New Mexico, and the movements for the revision of their water laws have attained considerable force in the remaining States and Territory.

The technical studies included in the work of the second class have shown that not more than half the water diverted from streams reaches the land for which it is diverted, due to losses in transportation, and that further losses occur by percolation and seepage after the water has been applied to the land. The statement that not more than one-third of the water diverted from streams actually performs useful work in plant production is prob-

ably conservative. In many sections the limit of irrigation development has been reached under present practice, because of the exhaustion of the water supply, and the saving of the losses shown by measurements presents in some sections the only means of future expansion, and in others the most promising means, because of the fact that the savings are inexpensive when compared with the cost of development of additional supplies of water. For this reason the prevention of losses has become a very prominent feature of the work. This work consists in experiments with ditch linings to determine their cost and efficiency; experiments with other methods of checking seepage losses; experiments in applying water by different methods and in different degrees of cultivation after irrigation to determine their effectiveness in checking losses of water by evaporation from the fields after being watered; and by percolation into the subsoil beyond the reach of plant roots. A further effort along this line is to determine the actual water requirements of different crops on different types of soil, in order that use may be limited to the necessities of the crops grown. The work so far done seems to justify the conclusion that the area irrigated with the present available water supply can be approximately doubled without injury to the present areas.

The work just referred to is confined principally to the region where crops can not be grown without irrigation. There are large sections both east and west of the arid region where farmers can maintain themselves without irrigation, and the principal question relating to irrigation is whether it will pay; in these localities experiments are being carried on to determine cost and returns, as well as the best methods.

In the semiarid plains, where stock raising and "dry farming" are and must be the principal industries, on account of the limited water supply, experiments are being carried on to determine the possibilities and costs of securing water supplies for the irrigation of small areas in connection with more extensive farming or stock raising, and the returns which may be expected from such irrigation. This involves investigations of pumping from the ground water, and of the construction of reservoirs for the storage of storm waters, and the use of the water supply secured in this way. For this purpose farms are maintained at Cheyenne and Newcastle, Wyo., and Eads, Colo.

Even in the humid sections of the East, irrigation of truck and fruit crops is proving profitable. The methods used are extremely expensive, and here experiments to cheapen methods are being carried on.

Of equal importance with the investigations outlined is the work of the third class, the supplying of practical information to water users. Very large areas previously uncultivated are now being supplied with water, and the settlers for these lands must come, very largely, from sections where irrigation is not practiced. In addition to the burdens incident to reclaiming new lands, the settler will be obliged to pay high prices for water and at the same time learn a new type of agriculture. Without assistance many will fail, and the work in this field is to protect them so far as possible from expensive mistakes in the methods of using water.

DRAINAGE INVESTIGATIONS.

The drainage work of the Office includes studies and experiments in reclaiming lands in the arid regions which have been injured by seepage or by the accumulation of alkali, and also the examination of swamp and wet lands in the humid regions which may be profitably reclaimed for agriculture.

These investigations relate particularly to methods by which agricultural land may be drained; the preparation of plans for special and representative projects, and the supervision of experimental work; the installation of experimental drains in cooperation with States, counties, or individuals; making drainage surveys and estimates for comprehensive systems; advising with engineers and commissioners upon the merit of plans which have been proposed, and collecting and making public both technical and popular information upon land drainage.

The methods of draining irrigated farm lands have been studied experimentally in Utah, Washington, Wyoming, and California. The results of experiments so far conducted have encouraged the owners of seeped land in irrigated sections to undertake their reclamation in a more efficient and energetic manner. The Office is actively cooperating with owners of land in the Grand River Valley of western Colorado, in their attempts to drain seeped land and to prevent the extension of wet areas. The necessity for similar experimental investigations has developed in the irrigated lands of the lower Rio Grande Valley of Texas, and an engineer from the Office has been stationed at Brownsville for the special study of drainage in connection with irrigation in that region.

Investigations in the drainage of wet lands in the humid regions extend from the western border of the Mississippi Valley to the Atlantic coast. Drainage surveys have been made in the lowlands of the Mississippi and Missouri River valleys, where the reclamation of large areas of fertile land is contemplated—particularly in Arkansas and Mississippi. Plans for the comprehensive drainage of the upper St. Francis River basin in Arkansas and Missouri have received special attention during the last year, as well as those for the protection of a portion of the valley of the Congaree River in South Carolina, for the drainage of the Florida Everglades, and for large areas of the coast lands of North Carolina.

The Office is authorized particularly to assist farmers in developing the production of their lands by thorough drainage, especially in localities where the practice is not well understood, and also to test the drainage properties of lands by experiments designed for the purpose.

The collection of technical and scientific facts regarding land drainage for the use of engineers, commissioners, and others who are intrusted with various kinds of agricultural drainage works, is an important part of the work of the Office. Among these may be named the determination of the volume of run-off for different classes of farm lands, under different climatic conditions, the behavior and maintenance of large canals, the resistance to flow in channels offered by various kinds of obstructions, as well as the economy of construction and the industrial advantages to be derived from the work.

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